VEGETATIONAL CHARACTERISTICS OF TWO STANDS OF JOSHUA TREE WOODLAND

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Abstract

Quantitative study of two superficially similar stands of Joshua tree woodland showed much variation. One stand included Joshua trees and junipers in the tree layer. The other stand also included piñon pine and desert scrub oak and had a different order of shrub importance values. Both stands contained shrubs characteristic of other plant associations. A list is presented of the annuals and biennials in flower in May, 1978.

Although Joshua tree is considered well known, Vasek and Barbour (1977) presented the first quantitative data published for any Joshua tree woodland—from a single stand in northeastern San Bernardino County. In May, 1978, we surveyed two stands of Joshua tree woodland on the road to Key's View, 6.4 km south of Cap Rock in Joshua Tree National Monument, Riverside County, at an elevation of 1470 meters. This paper presents an analysis of two stands of Joshua tree woodland including trees, shrubs, and those herbs flowering in May, 1978.

Joshua tree woodland is desert scrub vegetation of *Yucca brevifolia* associated at its upper levels with *Pinus monophylla, Juniperus californica,* or *Quercus turbinella,* and at its lower limits with *Larrea tridentata.* Beneath the open canopy are a variety of shrubs and, in good rainfall years, many flowering herbs. Treatments of this vegetation may be found in Webber (1953), Benson and Darrow (1954), Miller and Stebbins (1964), Jaeger (1957, 1967), and Vasek and Barbour (1977).

Methods

We took 40 point-centered-quarter samples in each of two seemingly similar stands that we consider typical of this elevation in the Joshua tree area as studied over a period of 30 years (e.g., Juhren et al., 1956). In each 90° quarter around each point, we determined crown cover and point-to-plant distance for the nearest tree and shrub. Quarters were set on compass directions starting 50 m from the road in four transects spaced 20 m apart. Each successive point was located so that no plant was counted twice. We used crown cover rather than stem diameter because the junipers have many trunks and the diameter of Joshua trees changes in relation to stem water content. We calculated crown cover by taking the mean of the largest and smallest diameters of each tree and shrub crown. From these data we calcu-

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lated absolute density, cover, and frequency and derived an importance value (IV) based on relative density, cover, and frequency (Mueller-Dombois, 1974).

Stand one, east of the road, had a gentle (5°–8°) slope to the southeast and extended 800 m along the road and 770 m eastward. Stand two, west of the road and approximately 20 m higher, was flatter and extended 700 m along the road and approximately 600 m westward. Each was dominated in appearance by Joshua tree. Soils of both stands are fine, gravelly, decomposed granite.

The total rainfall from June, 1977 thru April, 1978 was 22.9 cm, 13.2 cm more than normal. Monthly totals with departure from mean in parentheses were: J 0.00 (−.05); J 1.42 (.10); A 9.35 (7.59); S 0.13 (−.71); O 0.00 (−1.17); N 0.00 (−.78); D 1.47 (.41); J 5.26 (4.16); F 2.31 (1.83); M 2.26 (1.61); and A 0.66 (.38) cm.

Mean annual temperature in this area is 20.2°C and this year's departure from normal was only −.5°C. Mean monthly temperatures and departure from normal beginning in June 1977 were: J 29.2 (1.8); J 31.5 (.11); A 30.2 (−.24); S 26.1 (−.79); O 21.9 (1.2); N 15.7 (1.8); D 12.6 (2.8); J 9.8 (.57); F 12.1 (.49); M 15.3 (1.24); A 17.6 (−.84)°C.

All temperature and rainfall measurements are from the Twentynine Palms weather station, 25 km northeast of the study site.

Results and Discussion

Vegetational characteristics of the two adjacent stands are presented in Table 1. Stand one included Joshua trees and juniper in the tree layer and stand two included piñon pine and desert scrub oak as well. Importance values in the table are calculated for the whole stand (trees plus shrubs) for comparison with Table 24-6 in Vasek and Barbour (1977). Their IV for Joshua tree is 4 (density of 125/ha), compared with our IV of 27 (60/ha) in stand one and 19 (50/ha) in stand two.

These stands are considered phases of Joshua tree woodland as described by Munz and Keck (1940) because stands include the indicator species *Yucca brevifolia, Juniperus californica, Salazaria mexicana, Lycium cooperi, Eriogonum fasciculatum,* and *Tetradymia spinosa* var. *longispina*. Stand two has the following piñon-juniper woodland indicator species: *Pinus monophylla, Juniperus californica, Quercus turbinella* subsp. *californica, Purshia glandulosa,* and *Yucca schidigera*. Thus, stand two may be considered transitional. Other understory shrubs are characteristic of other communities. For example, Benson and Darrow (1954) indicate that *Thamnosma montana* occurs at 600–1200 m on rocky or gravelly desert slopes and mesas and *Haplopappus linearifolius* occurs in sagebrush and creosote bush deserts. Vogl (1976) lists *Purshia glandulosa* and *Yucca schidigera* for piñon-juniper woodland and states that *Ephedra viridis* occurs in higher creosote bush deserts. Other examples are *Coleogyne ramosissima, Purshia glandulosa,* and *Tetradymia spinosa* var. *longispina,*

Table 1. Vegetational Characteristics for Two Stands of Joshua Tree Woodland, Lost Horse Valley, Joshua Tree National Monument, California. Density = #/ha; Cover = m^2 crown cover/ha; Frequency = points of occurrence/(total points × 100); IV = importance value. Roman numerals identify stands.

	Density		Cover		Frequency		IV	
Taxon	I	II	I	II	I	II	I	II
Trees								
Juniperus californica	60	80	600	500	90.0	80.0	40	37
Pinus monophylla		10		200		20.0		11
Quercus turbinella subsp. californica		30		200		45.0		18
Yucca brevifolia	60	50	100	100	95.0	58.0	27	19
Shrubs								
Coleogyne ramosissima	70	80	60	800	4.0	40.0	3	60
Echinocereus mojavensis	20	20	<0.1	<0.1	2.5	2.5	1	2
Encelia farinosa		30		20		12.5		4
Ephedra viridis	60	130	350	280	37.5	17.5	31	17
Eriogonum fasciculatum	2140	960	1320	520	77.5	57.5	98	62
Gutierrezia microcephala		30		20		5.0		2
Haplopappus linearifolius	20	160	10	140	2.3	15.0	1	13
Hymenoclea salsola	290	80	230	50	12.5	15.0	16	8
Lycium cooperi	60		30		5.0		3	
Nolina parryi		50		50		7.5		6
Opuntia basilaris	60		60		2.5		4	
O. echinocarpa	130		70		7.5		7	
Prunus fasciculata		20		80		2.5		3
Purshia glandulosa		50		90		7.5		7
Salazaria mexicana	630	30	320	40	25.0	2.5	27	2
Tetradymia spinosa var. longispina	130		70		7.5		7	
Thamnosma montana	920	350	230	200	42.5	35.0	35	26
Yucca schidigera		40		20		5.0		2

indicators of sagebrush scrub, and *Hymenoclea salsola, Encelia farinosa,* and *Opuntia basilaris,* indicators of creosote bush scrub. These scrub communities are at lower elevations than the present study site and the occurrence of these species here must indicate suitable understory microenvironments.

The order of importance values for shrubs is different in the two stands. When shrubs alone are compared, the sequence in stand one is: *Eriogonum fasciculatum, Thamnosma montana, Ephedra viridis, Salazaria mexicana, Hymenoclea salsola, Coleogyne ramosissima, Haplopappus linearifolius.* In stand two the sequence is: *Eriogonum fasciculatum, Coleogyne ramosissima, Thamnosma montana, Ephedra viridis, Haplopappus linearifolius, Hymenoclea salsola, Salazaria mexicana.* The greater importance of *Coleogyne ramosissima* and *Hymenoclea salsola* and the presence of *Eriogonum fasciculatum, Gutierrezia microcephala, Prunus fasciculata, Purshia glandulosa,*

Nolina parryi, and *Yucca schidigera* in stand 2 indicate more diverse topographic microenvironments there.

Rain was much above average, especially in August, 1977 and January, 1978, so winter annuals and some perennial herbs were in flower at the time of this study. Annuals encountered in sampling were *Anisocoma acaulis, Baileya pleniradiata, Chaenactis fremontii, Eriophyllum pringlei, E. wallacei, Layia glandulosa, Malacothrix glabrata* (Asteraceae); *Amsinckia tessellata, Cryptantha similis, Cryptantha* sp. (Boraginaceae); *Nama demissum, Phacelia crenulata, P. distans, P. fremontii* (Hydrophyllaceae); *Salvia columbariae* (Lamiaceae); *Camissonia claviformis, Oenothera deltoides* (Onagraceae); *Gilia* sp., *Langloisia mathewsii, Linanthus aureus* (Polemoniaceae); *Chorizanthe thurberi, Eriogonum pusillum* (Polygonaceae).

Perennials and biennials were *Lomatium mohavense* (Apiaceae); *Baileya multiradiata,* (Asteraceae); *Arabis holboellii* var. *pinetorum, Erysimum capitatum, Lepidium* spp. (Brassicaceae); *Euphorbia polycarpa* (Euphorbiaceae); *Astragalus lentiginosus* var. *variabilis, Astragalus* sp., *Lupinus* sp. (Leguminosae); *Mirabilis bigelovii* (Nyctaginaceae); *Castilleja* sp., *Penstemon* sp. (Scrophulariaceae).

Broader information is needed on the herbaceous species to determine whether any are indicator species for Joshua tree woodland.

It is obvious from a comparison of our two stands with that of Vasek and Barbour (1977) that much variation occurs in Joshua tree woodlands that seem superficially similar. We conclude that many more data are needed before stand variation in this association is understood.

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NOTEWORTHY COLLECTIONS

Ophioglossum lusitanicum L. subsp. californicum (Prantl) Clausen (Ophioglossaceae).—USA, CA, Merced Co., along Co. Rd. J-16 (Merced Falls Rd.), ca. 2.4 mi (3.8 km) w. of North Side Canal bridge, w.- to s.w.-facing slope ca. 300 m s. of road and along fence row, 25 Apr 1978, *T. Duncan* (with *W. H. Wagner, Jr., A. Smith, T. Lowrey, L. Cserr*) *2759* (UC); Mariposa Co., above Lake McSwain along Merced River at Lake McSwain Rd. and Lake McClure Rd., ca. 0.5 mi (0.8 km) e. of intersection with Co. Rd. J-16, 25 Apr 1978, *Duncan* (et al.) *2757* (UC); Stanislaus Co., ca. 1 mi (1.6 km) n. of La Grange on Co. Rd. J-59 (La Grange Rd.), gravelly s.e.-facing slope above brook ⅛ mi (0.2 km) e. of road, 25 Apr 1978, *Duncan* (et al.) *2756* (UC). Basionym: *Ophioglossum californicum* Prantl; for a taxonomic account, see Clausen [Mem. Torrey Bot. Club 19(2):1–177. 1938].

Previous knowledge. Recorded by Clausen (op. cit., p. 160) from Amador, Monterey, and San Diego cos., also from the States of Baja California Norte and Mexico, Mexico; other subspecies occur in South America, Europe, Africa, Asia, Australia, and New Zealand. Howell and Long [Four Seasons 3(3):1–18. 1970] reported a 1970 collection from near La Grange by Perry Allen, and we have relocated this or a nearby population (cited above). There is also a sight-record from Tuolumne Co. by Perry Allen in 1969 (California Native Plant Society files). [Herbaria consulted: CAS, DS, JEPS, LA, OBI, POM, RSA, SD, UC; published sources: Clausen (op. cit.); Munz, A Calif. fl. 1959; Munz, A fl. S. Calif. 1974; Witham, Ferns San Diego Co. 1972.; Howell and Long (op. cit.); Howitt and Howell, Wasmann J. Biol. 22:1–184. 1964.] The only other species of Adder's-tongue fern in California is *Ophioglossum vulgatum* L., known from a single collection near Sisson, Siskiyou Co., collected in 1894. That species differs in having much larger, more elliptical blades.

Significance. This is the first report of the species from Merced and Mariposa counties. Several old collections are known from the vicinity of Ione, Amador Co. (the most recent collection in 1948 by Wagner), but recent attempts (by Wagner, 1975, and Smith, 1978) to relocate these populations have failed. Herbarium labels and published literature indicate that in the past this species has usually been collected around (at the margins of) vernal pools. However, it now appears that this may be only a "secondary" habitat. The "primary" habitat, at least in the Sierra foothills, seems to be in the Foothill Woodland Community (Munz, 1959) on s.-facing slopes of grazed pastures, with a sparse mixture of annual grasses (*Vulpia* sp., *Bromus* sp.) and forbs (*Erodium* sp., *Crepis* sp., *Juncus* sp., *Lepidium nitidum, Selaginella hansenii, Githopsis* sp., *Orthocarpus* sp., *Trifolium* sp., *Silene* sp., *Cerastium* sp.) with scattered trees of *Quercus douglasii*. The soil has a loose granitic gravel on the surface. Nearly all collections in the Sierra foothills have been made from February through April; after that the soil dries, the plants wither, and the aboveground parts die. During the summer, the ground is hard and baked, and there is no evidence of the plants.

Ophioglossum lusitanicum subsp. *californicum* (as *O. californicum*) has been included on the rare and endangered list of plants for California (Powell, Inv. rare and endangered vasc. pls. California. CNPS Spec. Publ. 1. 1974) and is under review as threatened by the Federal Government (Federal Register 40(127):27844. 1975). In all likelihood it is simply overlooked by collectors. The young leaves are spatulate, 0.5–2.5 (5.0) cm long, often somewhat conduplicate, and appear much like leaves or cotyledons of some small monocots. Fertile spikes are produced on fewer than 25 percent of the plants (perhaps less than 10 percent). Once the "primary" habitat was discerned (quite by